TS98-574
Serial number 09/310,256

APPEAL BRIEF

TO: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

From : George O. Saile (Reg. No. 19,572)
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Date: August 30, 2001

REF:
APPLICANT : Chin
SERIAL NO. : 09/310,256
ART UNIT : 1746
FILING DATE : 05/12/99
ATT'Y NO. : TSMC89-574
EXAMINER : Ahmed, S.
TITLE : A METHOD TO REDUCE PARTICLE LEVEL FOR DRY-ETCH

Sir:

In response to rejection of the claims in the above referenced application for United States Patent in an office action mailed on 08/27/01 and made FINAL, applicants filed a notice of appeal on 02/27/02. In accord with applicants' notice of appeal, please accept this appeal brief. No oral hearing is requested.

This action is in response to a Notice of Non-Compliance dated 08/12/02.

The Commissioner of Patents and Trademarks is hereby authorized to charge the fee of $320.00 associated with this appeal brief to Deposit Account No, 19-0033, along with any additional extension fee

Stephen B. Ackerman, Reg. No 37,761

CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as First Class mail in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, D C 20231, on September 12, 2002

Signature

9/12/02
Date

APPEAL BRIEF

1. Real Party in Interest

The real party in interest for this application is the assignee:

Taiwan Semiconductor Manufacturing Company
121 Park Avenue 3
Science Based Industrial Park
Hsinchu, Taiwan
Republic Of China

An assignment has been recorded for this United States Patent application.

2. Related Appeals and Interferences

There are no related appeals or interferences for this United States Patent application.

3. Status of the Claims:

Claims 1-22 remain in this application. Claims 1-22 have been finally rejected under 35 U.S.C. § 103. Claims 1-3 and 5-6 have been rejected under 35 U.S.C. § 102(b). No claims have been allowed.

4. Status of the Amendments:

An Amendment, dated 30 September, 2001, was submitted in response to an office action dated 27 August, 2001 and accepted. The proposed amendment will be entered.

5. Summary of Invention:

The invention teaches a multi-step method for shutting down the dry-etch process. The ICP rf power is reduced between each of these consecutive power-down steps of the dry-etch process, the complete power-down sequence consists of six steps. These six steps are executed in sequence and without interruption and form the totality of the dry-etch chamber power-down procedure.

Specifically:

- The instant inventions provides for a method of reducing dry-etch cleaning chamber particle count at the end of power-down for a dry-etch chamber by following a dry-etch chamber power-down procedure, powered-down in such a manner that foreign particle count inside the chamber is reduced at the end of the power-down cycle
- Prior Art provides for a method for reducing foreign matter deposited on a wafer during reactive ion etching (RIE)
- The invention therefore addresses the conventional concern that, using current one-step cleaning procedures results in a violent transition of the plasma in going from the operating condition of rf-on to rf-off by changing the conventional one-step cleaning process to a six step power-down procedure

that is performed at the end of the dry-etch chamber cleaning process.

CLAIM 1 IS READ ON THE SPECIFICATION AND DRAWINGS AS FOLLOWS:

1. Providing a method of reducing dry-etch cleaning chamber particle count at the end of power-down for said dry-etch chamber, comprising:

providing a dry-etch cleaning chamber, said dry-etch cleaning chamber having been provided with an Inductive Coupled Plasma (ICP) coil;

positioning a workpiece within said cleaning chamber; and

following a dry-etch chamber power-down procedure whereby

said power-down is applied in a controlled and gradual manner, assuring reduced chamber particle count at the end of power-down of the dry-etch cleaning chamber.

(THIS COMPLETES FIGS. 2a through 2e; SEE DESCRIPTION ON PAGES 10-13.

CLAIM 16 IS READ ON THE SPECIFICATION AND DRAWINGS AS FOLLOWS:

16. Providing a method of reducing particle count at the end of Power-down for an Inductive Coupled Plasma (ICP) dry-etch cleaning chamber, comprising the steps of:

providing a ICP dry-etch cleaning chamber;

positioning a workpiece within said cleaning chamber; and

following a dry-etch chamber power-down procedure, whereby said power-down is a six step power-down procedure, whereby said six steps of said power-down procedure follow in a given sequence and without interruption or time-lag in between any of said six steps, and whereby step 1 is specified as 30 mt/600 w ICP/15 w RIE/30 sccm O_2/2.5 min., whereby further step 2 is specified as 30 mt/560 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 3 is specified as 30 mt/520 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 4 is specified as 30 mt/480 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 5 is specified as 30 mt/440 w ICP/15 w RIE/30 sccm O_2/30, whereby further step 6 is specified as 30 mt/400 w ICP/15 w RIE/30 sccm O_2/30 sec.

(THIS COMPLETES FIGS. 2a through 2e; SEE DESCRIPTION ON PAGES 10-14.

Dependent claims 2-15 and 17-22 describe added important and critical/unexpected details based on experimental results relating to the independent claims.

6. Issues: Whether or not Claims 1-3 and 5-6 are anticipated by U.S. Patent 5,221,425 (Blanchard et al.). Further: whether or not Claims 1-22 are unpatentable over U.S. Patent 5,221,425 (Blanchard et al.).

7. Grouping of Claims: Claim 1 and dependent claims 2-15 form a first group of claims, claim 16 and dependent claims 17-22 form a second group of claims.

8. ARGUMENT

Regarding Claims 1-3 and 5-6 being anticipated by U.S. Patent 5,221,425 (Blanchard et al.) the following arguments apply:

Blanchard et al. provide for:

- (col. 1, line 8 e.a.): "a method for reducing foreign matter deposited on a wafer during reactive ion etching"; the instant inventions provides for, claim 1, "a method of reducing dry-etch cleaning chamber particle count at the end of power-down for a dry-etch chamber"; this is further confirmed by the instant invention by "following a dry-etch chamber power-down procedure" as specified in claims 7, 8-13, 14 and 15, independent claim 16 and the dependent claims (17, 18) to claim 16
- the difference between Blanchard et al. and the instant invention is essentially clear from the above mentioned item; that is Blanchard et al. provides for the deposition of foreign matter, which is deposited on a wafer during RIE. The

instant invention in contrast with Blanchard et al. reduces particle count, not during or as part of RIE processing, but after the reactive chamber has been used for RIE processing and the reactive chamber is, as part of the invention, powered-down in such a manner that foreign particle count inside the chamber is reduced at the end of the power-down cycle. This is confirmed by the claims of the invention, claim 1 identifies the "following a dry-etch chamber power-down procedure" which is further specified in claims 7, 8-13, 14, 14, independent claim 16 and the dependent claims 17 and 18 to claim 16

- as a further difference between Blanchard et al. and the instant invention, a quote is copied from the introductory statement of the specification of the instant invention, page 1, as follows: "and more specifically to a method to reduce the dry-etch chamber particle level during the power-down procedure of the dry-etch cleaning process for lithography masks"; from this follows that Blanchard et al. are concerned with reducing particle count on the surface of a wafer during RIE processing, the instant invention is concerned with and applies to reducing reactive chamber particle content and by thereby reducing particle concentrations on the surface of lithographic masks that are used in the reactive chamber

- to further quote from the specification of the instant invention, page 4: "Using current one-step cleaning procedures results in a violent transition of the plasma in going from the operating condition of rf-on to rf-off. This results in uncontrolled particle levels within the dry-etch chamber, a condition that is very detrimental to the proper operation and control of the dry-etch process. The present invention addresses this operational aspect of the dry-etch process and teaches a method of significantly reducing the particle count of residues or deposits of residual reaction products in the dry-etch chamber at the end of the dry-etch process."
- the instant invention changes the conventional one-step cleaning process (page 5 of the specification and Figs. 1a through 1e of the specification) to a sequence of six steps, that is the "power-down procedure" claimed in claims 1, 7, 8-13, 14 and 16 of the instant invention with the dependent claims thereto, also described using Figs. 2a through 2e of the specification
- Applicant respectfully concludes with the stated main objective of the invention, page 9 of the specification: "It is the primary objective of the invention to provide a method

of reducing particle count within the dry-etch chamber at the end of the dry-etch chamber cleaning process."

- Figs. 3a and 3b of the instant invention show a graphic depiction of the particle count for both the original Prior Art one step rf power-down mode and the multi-step rf power-down mode of the invention and
- Figs. 4a and 4b of the instant invention show a graph further illustrating the results obtained using the power-down procedure of the invention.

Regarding patentability of claims 1-22 of the instant invention over Blanchard et al., the following arguments apply:

Differences between Blanchard et al. and the instant invention have been highlighted above and can be summarized as follows:

- Blanchard et al. provide for a method for reducing foreign matter deposited on a wafer during reactive ion etching by following a procedure of reducing pressure in the chamber, by controlling the gas flow into the chamber, by de-activating the radio frequency voltage, by applying the reactive ion etching with magnetic enhancements, by deactivating the magnetic field applied to the chamber, all of these

conditions controlled and applied in a reactive ion etching process

- the instant inventions provides for a method of reducing dry-etch cleaning chamber particle count at the end of power-down for a dry-etch chamber by following a dry-etch chamber power-down procedure
- the difference between Blanchard et al. and the instant invention is essentially clear from the above mentioned item, that is Blanchard et al. provides for reducing the deposition of foreign matter which is deposited on a wafer during RIE, the instant invention reduces particle count, not during or as part of RIE processing, but after the reactive chamber has been used for RIE processing and the reactive chamber is, as part of the invention, powered-down in such a manner that foreign particle count inside the chamber is reduced at the end of the power-down cycle
- to quote from the specification, page 4: "Using current one-step cleaning procedures results in a violent transition of the plasma in going from the operating condition of rf-on to rf-off"
- the instant invention changes the conventional one-step cleaning process (page 5 of the specification and Figs. 1a through 1e of the specification), to a six step sequence of

steps, the "power-down procedure" that is claimed in claims 1, 7, 8-13, 14,14 and 16 with the dependent claims thereto, also described using Figs. 2a through 2e of the specification, providing a method of reducing particle count within the dry-etch chamber at the end of the dry-etch chamber cleaning process.

The use of ICP dry-etchers are specified by the invention in accordance with the following concerns, as addressed by the reference work "ULSI Technology" by C. Y. Chang and S./ M. Sze, page 349. e. a., a number of quotes are copied from this reference:

- "as feature sizes for ULSI continue to decrease, the limits of the conventional rf capacitive-coupled parallel system are being approached."
- "Other types of high-density plasma sources, such as inductive-coupled plasma (ICP) sources or helicon plasma sources, may become the main plasma sources for future ULSI processing."

From these two quotes it is clear that the invention provides a method of cleaning dry-etch processing chambers that is suited for and aimed at ULSI technology, that is a technology that is

considerably advanced from the technology that is addressed by Blanchard et al.

From the above arguments it can be stated in summary that claims 1-22 are patentable over Blanchard for the following reasons:

- Blanchard et al. does not address a power-down procedure but merely use power manipulation in the processing chamber to achieve reducing foreign matter on a wafer that is etched in a reactive ion etching process
- Blanchard et al. does not provide for reducing particle level during the power-down procedure of the dry-etch cleaning process for lithography masks
- Blanchard et al. does not provide methods and procedures for particle reduction that can be applied in an era of sub-micron. ULSI device features; for these latter technologies, ICP dry-etch chambers are one of the preferred dry-etch tools
- Blanchard et al. does not provide multiple processing parameters for a method for reducing foreign matter on a wafer but rely exclusively on control and adjustment of the rf voltage in the etch chamber; this differs from the instant invention where conditions for a power-down procedure include operating conditions of pressure, conditions of rf power

supplied to the ICP coil of the dry-etch chamber, conditions of rf power supplied for the RIE etch, a particular gas (O_2) entered into the dry-etch chamber and a time during which each of the six steps of the power-down procedure of the invention is to remain in force; this is specified in claims 8-13, claims 16, 17 of the instant invention; of further interest is that, for the processing conditions of the invention, the time of the steps is also varied with the first step of the power-down procedure requiring 2.5 minutes (claims 8, 16) while the remaining steps require 30 seconds (claims 9-13, 16, 17); this is therefore not a case of finding an optimum operating parameter, as provided by Blanchard et al., but of using a number of control parameters (not cited by Blanchard et al.) which collectively are aimed at and achieve reducing particle count at the end of the power-down cycle.

For all of the above highlighted reasons, it is respectfully submitted that claims 1-22 of the instant invention should be allowed over U.S. Patent 5,221,425 (Blanchard et al.).

Respectfully submitted,

Stephen B. Ackerman (Reg. No 37,761)

APPENDIX

The Claims outstanding in this application for United States Patent are as follows:

1. Providing a method of reducing dry-etch cleaning chamber particle count at the end of power-down for said dry-etch chamber, comprising:

providing a dry-etch cleaning chamber, said dry-etch cleaning chamber having been provided with an Inductive Coupled Plasma (ICP) coil;

positioning a workpiece within said cleaning chamber; and

following a dry-etch chamber power-down procedure whereby said power-down is applied in a controlled and gradual manner, assuring reduced chamber particle count at the end of power-down of the dry-etch cleaning chamber.

2. The method of claim 1 wherein said dry-etch chamber is of an Inductive Coupled Plasma (ICP) variety, said dry-etch chamber having a holding member with a surface which holds wafers or masks to be etched and an enclosing member which encloses the holding member to form a chamber for plasma, whereby plasma agitation occurs by an rf coil arrangement surrounding said enclosing member, whereby said rf coil

arrangement produces a large voltage change near the enclosing member thereby enabling cleaning of the enclosing member by the plasma, whereby furthermore plasma gasses can continuously be removed from said enclosing member by means of a suction pump arrangement attached to said enclosing member.

3. The method of claim 1 wherein said dry-etch cleaning chamber provides plasma gasses within the dry-etch cleaning chamber said providing to be followed by applying a RIE etch.

4. The method of claim 1 wherein said workpiece is a photolithography mask.

5. The method of claim 1 wherein said workpiece is the surface of a semiconductor substrate.

6. The method of claim 1 wherein said workpiece is any surface within the construction of a semiconductor device to which a dry-etch operation must be performed.

7. The method of claim 1 wherein said following a dry etch chamber power-down procedure is a power-down procedure whereby rf power supplied to an Inductive Coupled Plasma (ICP) coil is gradually reduced in a sequence of six steps, each of

said six steps to be executed as part of a sequence and without time interruption, each step immediately following a preceding step in numerical sequence, whereby a time during which Reactive Ion Etching (RIE) is applied varies and is adjusted in accordance with a step within the sequence, wherein said steps are identified as step 1 through step 6.

8. The method of claim 7 wherein processing conditions for said step 1 are specified as 30 mt/600 w ICP/15 w RIE/30 sccm O_2/2.5 min.

9. The method of claim 7 wherein processing conditions for said step 2 are specified as 30 mt/560 w ICP/15 w RIE/30 sccm O_2/30 sec.

10. The method of claim 7 wherein processing conditions for said step 3 are specified as 30 mt/520 w ICP/15 w RIE/30 sccm O_2/30 sec.

11. The method of claim 7 wherein processing conditions for said step 4 are specified as 30 mt/480 w ICP/15 w RIE/30 sccm O_2/30 sec.

12. The method of claim 7 wherein processing conditions for said step 5 are specified as 30 mt/440 w ICP/15 w RIE/30 sccm O_2/30 sec.

13. The method of claim 7 wherein processing conditions for said step 6 are specified as 30 mt/400 w ICP/15 w RIE/30 sccm O_2/30 sec.

14. The method of claim 7 wherein said six step power down procedure is modified to a sequence of N steps, wherein N is a whole integer number other than zero, processing conditions for each consecutive step are specified as 30 mt/AA w ICP/15 w RIE/30 sccm O_2/30 sec., wherein said AA w ICP represents a value of applied power for consecutive steps within said sequence, said applied power to decrease concurrent with increases in a value of N and whereby said applied power varies from an initial high value to a final low value, whereby said incremental numbers may or may not be multiples of AA/N and whereby furthermore said initial high and final low values are experimentally determined and optimized for each dry-etch chamber power down procedure.

15. The method of claim 1 wherein said following a dry-etch chamber power-down procedure is a power-down procedure whereby

rf power supplied to an Inductive Coupled Plasma (ICP) coil is reduced in a sequential and controlled manner during an time of a cleaning process of said dry-etch chamber, whereby at all times during said time there is a one-to-one relationship between rf power supplied to an Inductive Coupled Plasma (ICP) coil and time of a cleaning cycle, said relationship being defined by a specific mathematical equation.

16. Providing a method of reducing particle count at the end of Power-down for an Inductive Coupled Plasma (ICP) dry-etch cleaning chamber, comprising the steps of:

providing a ICP dry-etch cleaning chamber;

positioning a workpiece within said cleaning chamber; and

following a dry-etch chamber power-down procedure, whereby said power-down is a six step power-down procedure, whereby said six steps of said power-down procedure follow in a given sequence and without interruption or time-lag in between any of said six steps, and whereby step 1 is specified as 30 mt/600 w ICP/15 w RIE/30 sccm O_2/2.5 min., whereby further step 2 is specified as 30 mt/560 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 3 is specified as 30 mt/520 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 4 is specified as 30 mt/480 w ICP/15 w RIE/30 sccm O_2/30 sec., whereby further step 5 is specified as 30 mt/440 w ICP/15 w RIE/30 sccm O_2/30,

whereby further step 6 is specified as 30 mt/400 w ICP/15 w RIE/30 sccm O_2/30 sec.

17. The method of claim 16 wherein said six step power down procedure is modified to a sequence of N steps, wherein N is a whole integer number other than zero, where processing conditions for each consecutive step are specified as 30 mt/AA w ICP/15 w RIE/30 sccm O_2/30 sec, wherein said AA w ICP represents a value of applied power for the consecutive steps within said sequence, said applied power to decrease concurrent with increases in a value of N, whereby said applied power varies from an initial high value to a final low value.

18. The method of claim 16 wherein said following a dry-etch chamber power-down procedure is a power-down procedure whereby rf power supplied to an Inductive Coupled Plasma (ICP) coil is reduced in a sequential and controlled manner during time of a cleaning process of said dry-etch chamber, whereby at all times during said time there is a one-to-one relationship between rf power supplied to the ICP coil and time of a cleaning cycle.

19. The method of claim 16, said dry-etch chamber having a holding member with a surface which holds wafers or masks to be etched and an enclosing member which encloses the holding member

to form a chamber for a plasma, whereby plasma agitation occurs by an rf coil arrangement surrounding said enclosing member, whereby said rf coil arrangement produces a large voltage change near the enclosing member thereby enabling cleaning of the enclosing member by the plasma, whereby furthermore plasma gasses can continuously be removed from said enclosing member by means of a suction pump arrangement attached to said enclosing member.

20. The method of claim 16 wherein said workpiece is a photolithography mask.

21. The method of claim 16 wherein said workpiece is the surface of a semiconductor substrate.

22. The method of claim 16 wherein said workpiece is any surface within the construction of a semiconductor device to which a dry-etch operation must be performed.